Estimation of Fish Intake in Asian and White Female Adolescents, and Association with 2-Year Changes in Body Fatness and Body Fat Distribution: The Female Adolescent Maturation Study

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ABSTRACT

Background Fish is an important source of long-chain n-3 fatty acids in the diets of female adolescents, which may affect adipose tissue deposition.

Objective The purpose of this study was to evaluate fish intake in Asian and white female adolescents, and to determine whether fish intake was associated with changes in body fatness and body fat distribution in this population.

Design A cross-sectional analysis of fish intake using 3-day food records (n=200), and a prospective analysis of baseline fish intake on anthropometric measurements 2 years later was conducted (n=103).

Participants/setting Participants included female adolescents (aged 9 to 14 years) who were recruited from the Kaiser Permanente Oahu membership database in 2000-2001 as part of the Female Adolescent Maturation study (N=349).

Statistical analysis Fish intake and the proportion of participants eating 8 oz fish per week was compared between Asian, white, and mixed Asian/white ethnic groups using Kruskal-Wallis test, Wilcoxon rank sum test, and χ^2 test, respectively. The effect of fish intake on anthropometric measurements was assessed using Spearman's rank correlation coefficient and linear regression analyses, adjusting for demographic, pubertal, anthropometric, activity, and dietary parameters.

Results Asians consumed more fish (0.85 oz/wk [range=0.00 to 4.74 oz/wk]) than whites (0.00 oz/wk [0.00 to 0.40 oz/wk]; P=0.0001), and were more likely to eat 8 oz fish per week (13 of 68 vs 2 of 51, respectively; P=0.014). Greater fish intake corresponded to smaller changes in waist circumference when controlling for age, ethnicity, puberty, activity, energy intake, and baseline waist circumference (P=0.026), but not after adjusting for parental and additional dietary parameters (P>0.10).

Conclusions Most female adolescents did not consume the recommended amount of fish, a problem that was more common in whites than Asians. The protective effect of fish intake on abdominal obesity warrants further study.
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OBESITY IS A MAJOR CONCERN AMONG FEMALE adolescents in the United States, where an estimated one third have a body mass index (BMI) ≥85th percentile for age and sex.[1] Although overweight and obesity are typically defined using BMI, body fatness and distribution of fat in the body are the underlying factors that link excess body weight to disease risk.[2-4] Dietary patterns are thought to be an important determinant of obesity risk through their effect on energy balance, but little is known about the influence of dietary components on the partitioning of excess energy toward adipose tissue and on fat distribution in the body.

Fish is a nutritionally significant component in the diet because it is one of the few sources and main contributors to long-chain n-3 fatty acid intake.[5] In recognition of the importance of fish in nutrition and health, the US Department of Agriculture,[6] Academy of Nutrition and Dietetics and Dietitians of Canada,[7] and the American Heart Association and the American Academy of Pediatrics[8] recommend that adolescents consume approximately two servings or 8 oz fish per week. However, a study of >1,000 9th-grade students found only 36% reported that they eat fish at least once per week despite the fact that most (89%) believed that fish was healthy.[9]

Long-chain n-3 fatty acids are known to affect lipid metabolism in the body through their effects on transcription factors, including peroxisome proliferator-activating receptors, and sterol-regulatory element binding proteins, which reduce lipogenesis and promote fat oxidation.[10,11] Studies using animal models of obesity have observed a decrease in body fat[12-14] and visceral fat measured by dissection[12,13] with long-chain n-3 fatty acid intake. These effects have not been investigated in human beings. However, Asian-American women, particularly those who follow a more traditional Asian diet, have higher fish intakes than whites,[15,16] but partition a greater portion of body fat in the trunk.[17] Fish vary dramatically in their long-chain n-3 fatty acid content,[18] which may explain this contradiction.

The purpose of this study was to compare the distribution and adequacy of fish intake in Asian, white, and mixed Asian/white female adolescents, and to examine the effect of fish intake on changes in body fatness and distribution of body fat in this population over a 2-year period.

METHODS

Data for this study were collected as part of the Female Adolescent Maturation study, which has been described previously.[17] Female adolescents (aged 9 to 14 years) were recruited from the Kaiser Permanente Oahu membership database in 2000-2001 (Exam 1 N=349) and followed prospectively. Participants who were known to have chronic diseases or asthma, or who were prescribed steroid or anti-epileptic medications were not recruited. Only participants who identified themselves as Asian, white, or a mixture of only Asian and white ethnicities (n=214; 61.5%) were included. An additional 14 participants who did not complete the dietary records were excluded, leaving 200 (57.5%) Asian and/or white female adolescents for analysis of fish intake. Of this sample of 200 subjects, 104 (52.0%) participated in the first follow-up examination (Exam 2), which was conducted 2 years±2 months later. One of these participants was missing anthropometric variables, so 103 out of 200 (51.5%) were used to evaluate the effect of fish intake on changes in body fatness and fat distribution. The Kaiser Permanente Hawaii and University of Hawaii Institutional Review Boards approved this study.

Information on participant's age, ethnicity, and physical activity, as well as mother's and father's body weight, height, and education were collected through questionnaires in Exam 1 and Exam 2, respectively. Ethnicity was reported by parents/guardians based on proportion of Asian or white ethnicity in the biological mother and father, which was used to determine the percent Asian ethnicity of the participant.[17] For example, a girl with a father who was 50% Asian and 50% white, and a mother who was 100% Asian, would be considered to be 75% Asian and 25% white. The proportion of Asian ethnicity was used to classify subjects as Asian (100% Asian), white (0% Asian), or mixed (1% to 99% Asian). Asian ethnicities included Japanese, Korean, Chinese, Filipino, Indian, Thai, and Vietnamese. Total physical activity was calculated as the sum of reported activities that were performed at least 10 times during the previous year by converting frequency and duration of activity into metabolic equivalents based on values published by Lee and colleagues.[19] Mother's and father's BMI was calculated from body weight and height as a indicator of weight status (BMI was determined by the equation weight in kilograms/height in meters^2), and education was reported on a 6-point Likert scale (0=did not complete high school; 1=completed high school; 2=completed post-high school training [excluding college]; 3=completed some college/community college; 4=graduated from a 4-year college or university; and 5=attended and/or completed graduate school).

Participants were asked to complete a 3-day food record (Thursday, Friday, and Saturday) with dietary supplement questionnaire 1 week before Exam 1 and Exam 2 with the assistance of their parent or guardian(s). To improve accuracy, detailed examples of food records and dietary supplement questionnaires, and measuring tools (including measuring cup and spoon) and a ruled edge of paper were provided. Food records were analyzed at the University of Hawaii Cancer Center using the Shared Nutrition Food Composition Data Base (version 1999), which contains food group and nutrient data from the US Department of Agriculture databases that have been supplemented with foods commonly eaten by ethnic groups in Hawaii.[17,20] The mean of 3-day dietary intakes were used for analyses, and included absolute intake of energy, fish, and sweetened carbonated beverages; percent of energy from protein, fat, carbohydrates, saturated fatty acids, polyunsaturated fatty acids, and discretionary fat; and nutrient density (amount per 1,000 kcal) for added sugar, iron, and fiber. Fish intake was subcategorized into high and low n-3 fatty acid content as per the MyPyramid Food Guidance System Education Framework.[20] The use of dietary supplements made from fish oil or containing n-3 fatty acids was obtained from the dietary supplement questionnaire.

Mean daily fish consumption was multiplied by seven to provide more tangible amounts, and to allow for direct comparison to dietary recommendations, which are based on weekly intake.[6,7] The frequency of fish consumption was determined based on the proportion of the three 24-hour dietary records that contained any fish. Among participants that consumed fish, the mean amount of fish consumed on a fish consumption day was calculated by dividing 3-day fish intake by the number of days in which fish was eaten. In addition, the proportion of high and low n-3 fatty acid fish consumption days with at least a 3-oz intake of high and low n-3 fatty acid fish was determined. The decision to use 3-oz intake was made post hoc due to the limited number of 4-oz consumption days for high (n=2) and low (n=8) n-3 fatty acid fish. Finally, participant high-n-3 fatty acid fish intake was divided by their total fish intake and multiplied by 100% to estimate the percent of fish consumed that was high in n-3 fatty acids-containing sources.

Physical examinations were performed on participants to evaluate body composition and pubertal development. Body weight and height were measured using a digital scale (Seca) and stadiometer (Measurement Concepts) in kilograms and centimeters, respectively, by a standardized anthropometrist. Waist circumference was taken at the midpoint between the ribs and the iliac crest using inextensible measuring tape (Hoechst) in centimeters. Skinfold thickness was measured using Lange Skinfold Caliper (Beta Technology) in millimeters at the subscapular, triceps, biceps, and iliac sites. If duplicate measurements of body weight, height, waist circumference, or skinfold thickness were more than 2 units apart, a third measurement was taken, and the average of the two closest values was used. Total, trunk, and peripheral fat mass was assessed using dual-energy x-ray absorptiometry (DXA) (Lunar Prodigy) during Exam 2 only, and the ratio of trunk-to-peripheral fat was calculated according to the method of Novotny and colleagues.[17] Pubertal development was